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Original Research

Comparative Analysis of Conventional and Magnetic Resonance Hysterosalpingography for Evaluating Tubal Patency

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ABSTRACT:

Background:This study aims to compare conventional hysterosalpingography (HSG) and magnetic resonance hysterosalpingography (MRHSG) in assessing tubal patency. Conventional HSG uses contrast media to visualize the uterine cavity and fallopian tubes, while MRHSG utilizes magnetic resonance imaging (MRI) for detailed cross-sectional images. The research seeks to identify any differences or advantages between the two methods, contributing insights to reproductive medicine and potentially enhancing diagnostic accuracy in assessing female reproductive health.**Methods**:The study included 100 patients aged 20–40 for tubal patency evaluation, including those post-tubal ligation reversal and recurrent spontaneous abortions. Examinations occurred on Day 7–Day 12 of the menstrual cycle. **Results**:MR HSG and cHSG demonstrated comparative diagnostic performance, with sensitivity, specificity, PPV, NPV, and diagnostic accuracy for MR HSG at 100%, 99.08%, 100%, 97.5%, and 99.75%, respectively. Similarly, the comparison between MR HSG and DL revealed values of 100%, 93.73%, 87.21%, 100%, and 96%, respectively.The Kappa agreement between MR HSG and cHSG was excellent at 0.97, indicating substantial concordance. The McNemar test with a value of 1 showed no statistical difference between the two procedures, further affirming their comparable diagnostic efficacy.**Conclusion**:MR HSG represents a novel and emerging investigative method with limited prior exploration on both national and international fronts. This study stands out by uniquely delving into the practicality and applicability of conducting HSG through MRI, contributing to the growing body of knowledge in this evolving field.

Keywords:Magneticresonance,Hysterosalpingography,Tubalpatency.

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INTRODUCTION

Women grappling with infertility often embark on a diagnostic journey that involves a comprehensive array of laboratory tests and imaging studies. These investigations aim to uncover potential factors contributing to infertility, encompassing issues such as endocrine imbalances, congenital anomalies within the genital tract, uterine irregularities, and potential obstructions in the fallopian tubes.[1] Among the commonly employed imaging techniques for assessing tubal patency are hysterosalpingography (HSG), conducted under fluoroscopy, and contrast-enhanced hysterosalpingosonography. While these methods serve their purpose, they may fall short in providing a holistic evaluation, particularly regarding congenital uterine malformations and extrauterine diseases.Enter magnetic resonance imaging (MRI), a modality distinguished by its capacity to deliver an exhaustive and intricate anatomical survey. What sets MRI apart is its potential to delve into the intricate details of tubal patency, offering a more nuanced and comprehensive assessment. This becomes particularly relevant as cases of infertility often lead to referrals for MR imaging to explore potential uterine or extrauterine abnormalities. The unique advantage of MRI lies in its ability to concurrently evaluate tubal patency alongside other reproductive structures, presenting a more integrated and thorough approach to diagnostic imaging.The expansive capabilities of magnetic resonance imaging (MRI) transcend the singular focus on assessing tubal patency. MRI serves as a powerful tool for conducting thorough examinations, delving into both congenital and acquired conditions that may impact the intricate

structures of the reproductive organs.[2] This broader application allows healthcare professionals to adopt a more comprehensive approach to infertility evaluations.

Integrating MRI into the assessment of tubal patency provides a unique advantage by offering a holistic understanding of the myriad factors contributing to infertility. Unlike traditional methods that may provide limited insights, MRI's ability to capture detailed images and cross-sectional views enables a more nuanced exploration of the reproductive anatomy. This comprehensive diagnostic approach not only enhances the precision of diagnoses but also simplifies and refines the overall diagnostic process for women undergoing infertility evaluations.[3]Beyond its role in assessing tubal patency, MRI becomes a valuable asset in uncovering the complexities of reproductive health. It assists in identifying congenital anomalies, structural irregularities, and other conditions that might escape detection with conventional methods. The result is a more thorough evaluation that aids healthcare professionals in formulating targeted and personalized treatment plans based on a deeper understanding of the individual's reproductive health profile.The incorporation of MRI into infertility evaluations represents a paradigm shift, ushering in a new era of precision and comprehensive diagnostics. This not only benefits the individual undergoing evaluation but also contributes to advancing the field of reproductive medicine by embracing state-of-the-art imaging technologies that elevate the standard of care for infertility assessments.The versatility of MRI extends beyond merely assessing tubal patency. It facilitates a detailed examination of both congenital and acquired conditions affecting the reproductive organs.[4] By incorporating MRI into the evaluation of tubal patency, healthcare professionals can gain a more holistic understanding of the multifaceted factors contributing to infertility. This integrated diagnostic approach not only augments precision in diagnoses but also streamlines the overall diagnostic process for women undergoing infertility evaluations.In essence, the integration of MRI as a diagnostic tool holds the promise of offering a more detailed, comprehensive, and nuanced assessment of reproductive anatomy in a single imaging modality. This advancement not only has the potential to enhance diagnostic accuracy but also to refine the management and treatment strategies for individuals navigating the complex landscape of infertility.

MATERIALS AND METHODS

In this study, 100 female patients within the age range of 20 to 40 years underwent an evaluation of tubal patency. The cohort included individuals referred for postoperative assessment following the reversal of tubal ligation and those with a history of recurrent spontaneous abortions. The examinations were systematically conducted during the menstrual cycle, specifically between Day 7 and Day 12.To ensure the integrity and reliability of the study, certain exclusion criteria were applied. Patients who expressed dissent, displayed uncooperative behavior, had active pelvic inflammatory disease, or presented contraindications to magnetic resonance imaging (MRI) such as pacemakers or cochlear implants were excluded.[5] Rigorous adherence to ethical standards was maintained, and proper informed consent was obtained from all participating patients. The study design, characterized as a prospective controlled study, received approval from the Institutional Ethics Committee.To minimize potential confounding factors, patients were advised to abstain from sexual intercourse from the days following menstruation until the day of the procedure. This precaution aimed to eliminate any chance of pregnancy during the evaluation. Additionally, patients received premedication to enhance their comfort and mitigate potential discomfort associated with the procedure. This premedication included oral mefenamic acid administered three times a day and a course of antibiotics (a combination of ofloxacin and metronidazole). The antibiotic course commenced on the day before the procedure and continued for two days post-procedure.The actual tubal patency evaluation was conducted under strict aseptic precautions. An MRI-compatible plastic HSG 5-F microcatheter with an inflatable bulb was delicately inserted into the lower uterine cavity. Following insertion, the bulb was carefully inflated with 3 cc of distilled water. Subsequently, the patient was moved to an MRI scan 1.5 Tesla [GE] machine for a comprehensive imaging session. This meticulous process aimed to ensure accuracy in assessing tubal patency while prioritizing patient safety and comfort.Following the tubal patency assessment via MRI, patients were promptly transferred to the fluoroscopy room for further evaluation. In this phase, 10 ml of iodinated contrast iohexol (Omnipaque, GE Healthcare; 350 mg/ml) was introduced through the same catheter. A spot film was captured to visualize the contrast distribution, after which the balloon was deflated, and the catheter was carefully removed.[6,7]For patients identified with unilateral or bilateral tubal blocks during this assessment, a subsequent diagnostic laparoscopy (DL) was scheduled in the following menstrual cycle as part of routine further evaluation. The DL findings served to confirm the tubal blockages. Conversely, patients exhibiting bilateral tubal patency were placed on regular monthly follow-ups. If conception did not occur within three months, these patients underwent DL as part of extended evaluation within the Department of Obstetrics and Gynecology. The confirmation of findings was integral during the laparoscopic procedure.Notably, one patient achieved conception within two months, and consequently, they were not included in the study, as diagnostic laparoscopy was not performed for this particular individual. This strategic approach to

further evaluations and interventions underscores the study's commitment to thoroughness and clinical relevance in addressing reproductive health concerns.

RESULTS

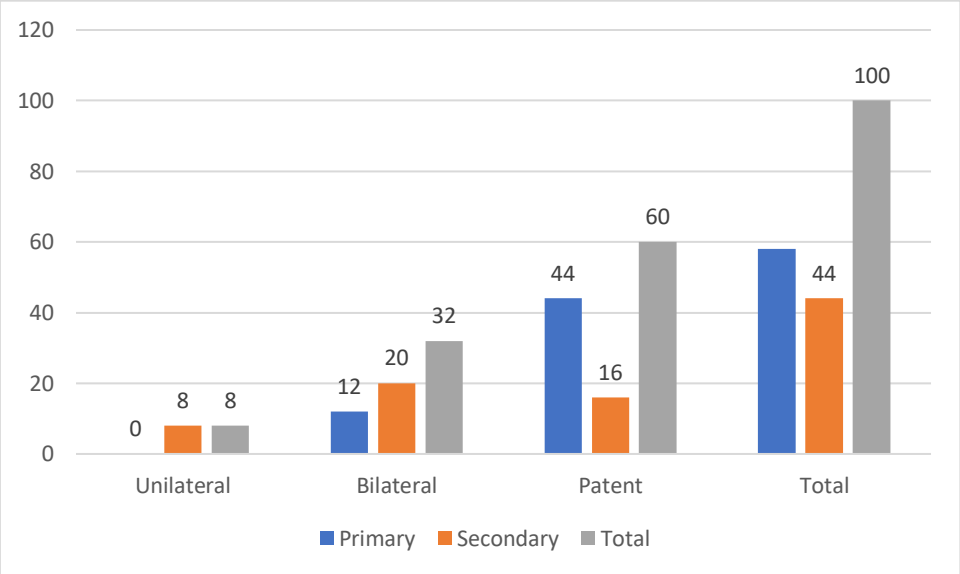
The comprehensive evaluation of 100 patients, both MR HSG and conventional hysterosalpingography (cHSG) were conducted simultaneously during the same session. Subsequent diagnostic laparoscopy (DL) was performed at intervals ranging from 1 to 3 months to validate and confirm the findings.The patient cohort consisted of 58 cases of primary infertility, constituting 56%, and 44 cases of secondary infertility, accounting for 44%. Among those with secondary infertility, a detailed breakdown revealed that 12 patients (12%) had a history of recurrent abortions, 20 patients (20%) had undergone tubectomy or tubal ligation reversal, and 12 patients (12%) experienced infertility of unidentified causes.

Analyzing the results of MR HSG, as presented in Table 1, revealed that out of the total 100 patients, 40 exhibited tubal blocks, while 60 showcased bilateral tubal patency. Among the 40 patients with tubal blocks, 32 had bilateral blocks, and 8 had unilateral blocks, with 4 cases identified in the right tube and 4 in the left tube.This detailed breakdown of the patient demographics and tubal status underscores the comprehensive nature of the study, capturing a diverse range of infertility scenarios. The utilization of both MR HSG and cHSG, followed by DL validation, enhances the reliability and accuracy of the findings, offering a robust foundation for a thorough understanding of tubal patency in the context of infertility.

Table 1: Results of MR HSG

Infertility	Unilateral	Bilateral	Patent	Total
Primary	0	12	44	56
Secondary	8	20	16	44
Total	8	32	60	100

Figure 1: Results of MR HSG



In the examination of a total of 200 fallopian tubes within the cohort of 100 patients, a detailed analysis revealed that 80 tubes were identified as blocked, while 120 tubes demonstrated patency. Representative cases illustrating bilateral tubal blocks and bilateral patencies are presented for clarity.In instances of unilateral blocks, the determination of the affected side was consistent between conventional hysterosalpingography (cHSG) and magnetic resonance hysterosalpingography (MR-HSG). However, a single case presented a discordance where cHSG identified spills from the right tube, marking the only instance of discrepancy between the two methods.Table 2 compiles the overall results derived from MR HSG, cHSG, and diagnostic laparoscopy (DL). This comprehensive tabulation encapsulates the outcomes of tubal evaluations, providing a consolidated view of the concordance and discordance between the imaging techniques and the subsequent validation through DL. The meticulous consideration of bilateral and unilateral findings enriches the study's ability to draw accurate conclusions regarding tubal status in the context of infertility.

Table 2: Results of MR HSG, conventional HSG, and D L

Type of HSG	U/L block	B/L block	Patent tubes
MR HSG	8 (R1, L3)	32	60
X-ray HSG	10 (R2, L3)	30	60
DL	16 (R4, L4)	24	60

DISCUSSION

The average age of the patients participating in this study was 25 years. An especially noteworthy aspect of this investigation was the successful completion of the study in all 100 patients, reflecting a high level of patient compliance.[8] This achievement is particularly significant when compared to previous studies conducted by Sadowski et al. and Winter et al., where the procedures had to be abandoned in a notable percentage of patients (1 out of 17 and 4 out of 37, respectively). This underscores the robustness and viability of the current study's approach, emphasizing its reliability and patient acceptability.Examining the distribution of tubal conditions within the study cohort, it was found that 60% of the patients exhibited bilateral tubal patencies, while 40% displayed bilateral tubal blocks. This pattern aligns closely with findings from a study by Cipolla et al., where 65% of patients had patent tubes, and 35% had either unilateral or bilateral tubal blocks. The consistency in these results across studies suggests a certain uniformity in the prevalence of tubal patency issues within the populations under investigation.Reflecting on the historical development of magnetic resonance hysterosalpingography (MR HSG), the first trial dates back to 1996 when Fred et al.[9] assessed its efficacy in 36 rabbit uterine horns. In this pioneering study, eight fallopian tubes were ligated, and 32 were left unaltered. The comparison with conventional hysterosalpingography (cHSG) revealed that cHSG correctly identified the presence and absence of spills in all 32 and 8 cases, respectively. Sensitivity and specificity figures for MR HSG were reported as 96.5% and 71%, respectively, for detecting tubal blocks. Importantly, there was no statistical difference between the results obtained through cHSG and MR HSG. This historical context not only highlights the initial steps in validating MR HSG but also emphasizes the method's effectiveness in comparison to the established cHSG.In summary, the current study stands as a testament to the success of MR HSG in assessing tubal patency, showcasing high patient compliance and contributing valuable insights that build upon the foundation laid by earlier pioneering studies in this field.

In 2000, Frye et al. conducted a feasibility study using a phantom that simulated the uterus, fallopian tubes, and the surrounding pelvic cavity. The study utilized a half Fourier RARE sequence for magnetic resonance hysterosalpingography (MR HSG). Subsequently, Weisner et al. in 2001 published a preliminary report on MR HSG with a small sample size of 5, concluding that MR HSG is a feasible technique that warrants further investigation.[10]In our study, within the conventional hysterosalpingography (cHSG) group, 20 patients exhibited tubal blocks, while 30 patients displayed tubal patencies. However, an interesting case in the primary infertility group showed bilateral blockage in MR HSG but a unilateral block in cHSG and diagnostic laparoscopy (DL). This was the sole instance of discordance between MR HSG and cHSG in our study, highlighting a rare divergence in results. Importantly, in all other cases, the findings were concordant between MR HSG and cHSG. Sadowski et al., in their study, identified six patent tubes using MR HSG that appeared blocked according to conventional methods. This discrepancy was attributed to the superior resolution of MRI in MR HSG. Conversely, James et al. contested this notion, asserting that the increased patency was solely due to the plastic catheter rather than the metallic cannula. Notably, in our study, the use of the same catheter in both MR HSG and cHSG, with the exception of one case where the balloon catheter was dislodged after MR HSG, minimized the potential confounding effect of catheter material.Our findings align with Unterwerger et al.'s[11] study, where 8 out of 10 cases demonstrated concordant results in both MR HSG and cHSG. Additionally, Cipolla et al. conducted a study in 2016 with 116 patients using a time-resolved 3D sequence on a 3T MRI, further supporting the reliability and concordance of results between MR HSG and cHSG in the assessment of tubal patency.These collective studies contribute to the growing body of evidence supporting the efficacy and concordance of MR HSG with traditional methods, emphasizing its potential as a valuable diagnostic tool in evaluating tubal patency.The study conducted by Fatemeh et al.[12] reported sensitivity and specificity values for hysterosalpingography (HSG) in detecting bilateral tubal patencies or tubal blocks as 96.1% and 88.7%, respectively. The positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy were documented as 97.2%, 68.7%, and 92.1%, respectively. Remarkably, the results obtained in our study align closely with these statistical values.

This congruence in findings between the two studies underscores the consistency and reliability of the diagnostic accuracy of HSG in assessing tubal patency. The similarity in sensitivity and specificity values, as well as positive and negative predictive values, suggests that HSG is consistently effective in identifying bilateral tubal patencies or tubal blocks. Such alignment in results enhances the robustness of the evidence supporting the diagnostic utility of HSG in the evaluation of tubal status, contributing to the cumulative knowledge in this field.

CONCLUSION

Magnetic Resonance Hysterosalpingography (MR HSG) stands out as an emerging investigative method, characterized by its novelty and a limited number of pioneering studies conducted at both national and international levels. The study in question distinguishes itself by delving into the utility and feasibility of Hysterosalpingography (HSG) conducted through Magnetic Resonance Imaging (MRI).The novelty of MR HSG lies in its application of advanced imaging technology to assess tubal patency and reproductive anatomy. The limited

number of existing studies underscores the nascent stage of development for this technique, emphasizing the need for comprehensive investigations to establish its efficacy and potential clinical applications.This particular study adds a valuable contribution to the field by focusing on the practical aspects and feasibility of employing MRI for HSG. By exploring the utility of MR HSG, researchers aim to uncover its strengths and limitations, providing insights that could shape its integration into routine clinical practice. As a distinctive endeavor, this study contributes to the groundwork essential for establishing MR HSG as a viable and effective diagnostic tool in the realm of reproductive medicine.

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